

A LAYERED APPROACH TO TECHNOLOGY TRANSFER OF AVIRIS BETWEEN EARTH SEARCH SCIENCES, INC. AND THE IDAHO NATIONAL ENGINEERING LABORATORY

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1. GENERAL

Since initial contact between Earth Search Sciences, Inc. (ESSI) and the Idaho National Engineering Laboratory (INEL) in February, 1994, at least seven proposals have been submitted in response to a variety of solicitations to commercialize and improve the AVIRIS instrument. These proposals, matching ESSI's unique position with respect to agreements with the National Aeronautics and Space Administration (NASA) and the Jet Propulsion Laboratory (JPL) to utilize, miniaturize, and commercialize the AVIRIS instrument and platform, are combined with the applied engineering of the INEL. Teaming ESSI, NASA/JPL, and INEL with diverse industrial partners has strengthened the respective proposals. These efforts carefully structure the overall project plans to ensure the development, demonstration, and deployment of this concept to the national and international arenas.

The objectives of these efforts include:

- developing a miniaturized commercial, real-time, cost effective version of the AVIRIS instrument
- identifying multiple uses for AVIRIS
- integrating the AVIRIS technology with other technologies
- gaining the confidence/acceptance of other government agencies and private industry in AVIRIS, and
- increasing the technology base of U.S. industry.

1.1 History.

The initial contact between ESSI and INEL began in February 1994, as ESSI was involved in discussions with the Idaho Department of Commerce (IDOC). ESSI, a small business within the state, approached the IDOC with a need for assistance from a large institution with the capability to develop a miniaturized version of the AVIRIS instrument that could be deployed on a commercial airborne platform. ESSI had an agreement under the Space Act to utilize the AVIRIS instrument for mineral exploration since 1987. ESSI had been working with NASA and JPL to improve the instrument, verifying and validating the results of the overflights as they were made. ESSI also concluded an agreement with NASA/JPL to re-deploy the AVIRIS from the ER-2 flight platform to NASA's C-130, fuse the AVIRIS data with that of other sensors on the C-130 platform, and to miniaturize and commercialize the instrument for use throughout the world. With an array of industrial partners in the U.S. and from other countries, ESSI assembled a world class team of potential partners who can provide unique capabilities for applications. TRW, Inc. joined the group in May 1994. In June, 1994, Tetra Tech, Inc., joined the ESSI and INEL efforts, adding their significant remote sensing and environmental reputation and expertise to the efforts. Tetra Tech is rated seventh of the top 200 small businesses in the United States by Forbes Magazine. Lockheed and several other firms followed Tetra Tech in October 1994, forming a team to use AVIRIS in Kazakhstan as a major cornerstone in the United States policy to convert defense industries to commercial entities. This has

been followed by the U.S. Environmental Protection Agency participating in a demonstration of the technology for environmental assessment and monitoring of large areas in place of traditional sampling methods. U.S. commercial and agricultural industries also expressed an interest in using the same technology to assess areas prior to purchase and to monitor existing operations. Today, the education community is attracted to the field of remote sensing and is using AVIRIS as a technical cornerstone to establish an international Remote Sensing Center of Excellence accompanied by graduate degree programs and a dedicated testing center in excess of 4,000 square miles at the University of Idaho.

1.2 Teaming.

As a small business, publicly-held, but sold in the penny stock market, ESSI has severely-limited funds to bring to the venture. Seeking funds from other partners or through joint solicitations with other federal agencies and federal entities is the primary means of securing capital. Signing Memorandums of Agreement (MOA), negotiating Cooperative Research and Development Agreements (CRADAs), and concluding Teaming Agreements with government and private industry has been the preferred route for ESSI to protect the intellectual property rights to the technology. These arrangements have increased the leveraging of funds and expanded the potential business opportunities. Business plans between team members are used to share the division of labor and profit.

2. PROPOSAL SOLICITATIONS

2.1 Advanced Projects Research Agency (ARPA) Technology Reinvestment Project (TRP).

This proposal was initiated to develop dual-use hyperspectral instruments for environmental, agricultural, mining, forestry and specific Department of Defense applications requiring unique signature identification. This \$6M proposal involves the design and construction of a real-time, miniaturized, commercial prototype hyperspectral instrument and developing a new family of hyperspectral instruments with industrial firms, including: TRW, Inc., Earth Search Science, Inc. (ESSI), National Aeronautic and Space Administration (NASA), Jet Propulsion Laboratories (JPL), WJT Software, Integrated Spectronics PTY, CALTECH, and EG&G Idaho. A MOA between TRW, Inc, Earth Search Science, Inc., NASA/JPL, and EG&G Idaho, Inc., was concluded between the partners. Upon award, a Teaming Agreement and a Business Plan will be produced.

2.2 Rocky Flats Request for Proposals.

This request resulted in another proposal entitled "Aerial Multispectral Sensor Platform for the Detection of Rocky Flats Hazardous (including Radiological) and Toxic Wastes". This \$1.4M effort proposes to characterize both hazardous (including radiological) and toxic wastes surveyed from an airborne multisensor platform at hovering altitudes, mid-level altitudes (30,00 ft.), and high altitudes (>60,00 ft.). The airborne platforms will be enhanced with non-radiological sensing capability, including, but not limited to, thermal imaging to detect vegetal stress, seeps, and other hydrological features; laser induced fluorescence; and electromagnetic imaging/magnetometer/ground penetrating radar coupled to video to provide better arrays and overcome the limitations of separate sensors. Data fusion, data compression, and data management are project keystones. All data collected in the flyovers will be fused into a geographic information system (GIS) data base. These

data will be used in the site-wide management information system affecting the environmental remediation of Rocky Flats Plant. A MOA was concluded between the partners. When an award is announced, a CRADA with the INEL will be executed.

2.3 Environmental Protection Agency (EPA) Environmental Technology Initiative (ETI).

This is a \$700K proposal to use the Fort Hall Indian Reservation as a demonstration site to evaluate the current monitoring capabilities and development needs of hyperspectral instruments used for environmental purposes. The technology demonstration will also be used to identify the extent of recurring pollution on the reservation (nitrates, ethylene dibromide, and assorted pesticides and herbicides). Non-point-source pollution cannot be adequately addressed by traditional sampling methods. Partners include the Shoshone-Bannock Tribe, the INEL, EPA, NASA/JPL, and Earth Search Sciences, Inc. (ESSI). EPA funding is being leveraged with ESSI providing \$3.5K. An MOA was concluded by the team to demonstrate the airborne multisensor platform and train Shoshone-Bannock Tribe personnel to use GIS to manage the reservation resources. When an award is announced, a CRADA will be executed.

2.4 EPA Requested Flyover of the San Jacinto River.

In October 1994, EPA requested ESSI's assistance to use the AVIRIS to assess the environmental impact of a gasoline pipeline break in the Houston, Texas area. With demonstration of the technology for environmental purposes over large land areas, EPA has indicated that remote sensing may be substituted for traditional, expensive and time-consuming sampling procedures. This may include monitoring the environmental status of the Gulf of Mexico coast and the U.S.-Mexico border area.

2.5 Retrofit of the AVIRIS to the NASA/JPL C-130 Multisensor Platform.

In October 1994, ESSI obtained JPL support to retrofit the AVIRIS instrument to the NASA C-130 aircraft. This will enable the AVIRIS instrument to collect 5 by 5 meter pixel data flying at 5,000 meter AGL, a 16-fold increase in spatial resolution over the resolution available currently with the ER-2 aircraft.

2.6 International Remote Sensing Center of Excellence.

The international Remote Sensing Center of Excellence's mission is to support watershed/river basin management as it affects all biota. Idaho was selected because the state is rich in potential sensor services users and developers and offers a natural laboratory for sensor platform testing and evaluation. The potential client base includes agriculture, range management, fisheries, mining, forestry, wildlife management, and human engineering.

2.7 Defense Nuclear Agency Defense Industry Conversion Solicitation.

This \$11M proposal is to use hyperspectral and multispectral imaging to explore for minerals, perform environmental assessments, manage national industries, such as agriculture and forestry, natural resource management, and land use planning for the Republic of Kazakhstan. The teaming arrangement, which consists of Lockheed Environmental Systems and Technologies, ESSI, Tetra Tech, Inc., Ramparts Technologies, Lockheed Idaho Technologies Company, NASA/JPL, EG&G Measurements, Las Vegas, Bishop Associates, SEMTECH (Kazakhstan industry partner), and Sciencetech, plans to begin operations in January 1995.

2.8 Latin America Initiative.

Several proposals have been developed to partner with industry, universities, and State and Federal agencies to develop, package, and deliver Department of Energy and ESSI competitive advanced technology products/services. This approach provides solutions to critical environmental restoration and waste management problems while furthering national business and technology goals. The proposals include providing environmental management education and training services to build an infrastructure in Mexico and are planned for expansion to Chile and Argentina. Use of the AVIRIS and other non-intrusive remote sensing technologies provides the technical foundation for this effort.

3. FUTURE PLANS

3.1 Solicitation Plans.

Through teaming with other firms, ESSI plans to continue to respond to future solicitations. This allows them to identify possible technology applications for remote sensing which far exceed its current capability to fulfill. Current partners include three firms based in the Washington DC area. One centers its efforts on federal government opportunities, the second focuses on international opportunities, and the third on major corporations which have remote sensing requirements. Where possible, these firms are included as teaming partners in proposals. None require up front financing to obtain potential remote sensing applications. All potential partners agree to allow ESSI to establish offices with little or no overhead costs, gain access to new markets, and obtain the services of other firms' marketing capabilities of products and services.

3.2 Relocation Plans.

ESSI is evaluating opportunities in relocating to southeast Idaho to more fully use national laboratory assets. National laboratories now offer a variety of services to small businesses. These range from CRADAs to use of the laboratory's staff and laboratories to being awarded contracts identified solely for small business. Ten percent of INEL's FY-95 \$1B budget is committed to small and minority businesses.

4. INTELLECTUAL PROPERTY PROTECTION IN US AND INTERNATIONAL ARENAS

ESSI current projects and outstanding funding proposals were reviewed by patent attorneys to determine appropriate actions to protect their intellectual property through patents, trademarks, and copyrights. Applications have been initiated to obtain patents for equipment, processes, and new applications of single and multiple remote sensing systems. Protection of intellectual property has been included in all Memorandums of Agreement, Teaming Agreements, and proposals. Other methods are also being used, such as the CRADA which allows commercially valuable data generated to be withheld from public release for up to five years, and teaming with firms currently doing business in international arenas.

5. CONCLUSION

ESSI has developed an approach to a costly technology development program that fully leverages the resources of others while retaining ownership, technical application and control, and management direction.